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Original article

A single-center experience of transitioning from a routine transfemoral to a transradial intervention approach in ST-elevation myocardial infarction: Impact on door-to-balloon time and clinical outcomes

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ABSTRACT

Background: In the emergent setting of ST-elevation myocardial infarction (STEMI), transradial intervention (TRI) is less frequently employed than transfemoral intervention (TFI). Because of the greater technical complexity of TRI, a potential compromise in door-to-balloon (DTB) time remains a major concern of centers adopting TRI for STEMI.

Methods: We performed a propensity-matched analysis, with 1:1 matching of TRI and TFI patients comparing DTB time, 30-day major adverse cardiac event (MACE), and bleeding outcomes of 1052 consecutive STEMI patients managed at our center during a 2-year transition program from routine TFI to TRI access for STEMI.

Results: From January 2008 to April 2010, 359 (34.1%) STEMI patients underwent TRI and the remaining 693 (65.9%) STEMI patients underwent TFI. In 283 propensity score matched pairs of TRI and TFI patients, TRI was associated with shorter DTB time (63.6 min vs 69.4 min, $p = 0.027$) and more patients having DTB time < 90 min (88.3% vs 82.3%, $p = 0.043$). Thirty-day MACE occurred in 1.0% in the TRI group and 3.0% in the TFI group ($p = 0.129$). There was no significant difference in major ($p = 0.313$) or minor bleeding ($p = 0.714$) between the TRI and TFI groups. There was a twofold greater use of glycoprotein (GP) IIb/IIIa inhibitor in the TRI group (68.5%) compared with the TFI group (36.4%) ($p < 0.001$).

Conclusion: Compared with TFI, TRI was not associated with longer DTB time during our center's transition from routine TFI to TRI in STEMI. Our experience suggests that the transition to TRI in STEMI can be safely achieved with DTB times that are comparable and possibly better than propensity-matched TFI cases.

Introduction

Transradial intervention (TRI) is increasingly becoming the preferred method of vascular access at many centers performing percutaneous coronary intervention (PCI). Compared with transfemoral intervention (TFI), perceived benefits of TRI include lower access site bleeding and greater patient comfort. Several studies have now shown significant reductions in bleeding and even ischemic complications with TRI in ST-elevation myocardial infarction (STEMI) [1–7].

Aggressive anti-thrombotic therapy is a cornerstone of primary PCI in order to limit the occurrence of thrombotic complications during and after the procedure. Hachinohe et al. reported that use of glycoprotein (GP) IIb/IIIa inhibitor with thrombus aspiration has a synergistic effect on clinical outcomes for patients with acute myocardial infarction [8]. Therefore, bleeding is one of the main concerns for operators. The radial artery is easily compressible, thus bleeding is controllable and hemorrhagic complications can be significantly reduced. Furthermore, TRI is associated with lower access site bleeding compared with TFI [1–4]; thus, a theoretical advantage of TRI over TFI is that more potent anti-thrombotic drugs can be administered prior to, or during, primary PCI.

There are concerns that a routine TRI approach may result in longer door-to-balloon (DTB) time compared with a routine TFI approach, particularly with centers considering the adoption of TRI in STEMI. In the emergent setting of STEMI where

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timely revascularization is paramount, technical concerns remain about radial artery access and negotiating tortuous subclavian and ascending aortic anatomy in patients with ongoing STEMI. We therefore sought to compare differences in DTB time, bleeding, and thrombotic outcomes among patients undergoing TRI and TFI for STEMI at a high-volume tertiary center newly adopting TRI in STEMI.

Methods

Study design

We conducted an observational study of 1052 Asian patients with STEMI undergoing primary PCI at a high-volume tertiary medical center in Singapore from January 2008 to April 2010. We included all patients who presented to the emergency department with STEMI and were eligible for primary PCI. All patients received a loading dose of aspirin 300 mg and clopidogrel 600 mg on arrival in the emergency department. Periprocedural use of GP IIb/IIIa inhibitors was determined by the primary operator in accordance with current guidelines [9]. Unfractionated heparin was administered at a bolus dose of 50–70 units/kg for all patients and adjusted to achieve an activated clotting time of 250–300 s and 300–350 s, respectively, for patients who did and did not receive GP IIb/IIIa inhibitors.

Door-to-balloon time was defined as time intervals between patients' arrival to the emergency department and the moment of first attempt to open the artery by thrombectomy, balloon insertion, or stenting. Major cardiac adverse events (MACE) of interest were death, myocardial infarction, and target vessel revascularization that happened in the catheter laboratory, or within 30 days post-PCI follow-up that was done through telephone calls and clinic visits. The definition of major bleeding include the cumulative occurrence within 30 days after PCI of intracranial or intraocular bleeding, hemorrhage at the access site requiring intervention, hematoma with a diameter of at least 5 cm, a reduction in hemoglobin levels of at least 4 g per deciliter without an overt bleeding source or at least 3 g per deciliter with such a source, reoperation for bleeding, or transfusion of a blood product which were based on the ACUITY trial [10]. Minor bleeding was defined as any bleeding that did not meet the above major bleeding criteria. Follow-up information was obtained from the hospital records. The primary outcomes were DTB time, major and minor bleeding, and MACE within 30 days after the index procedure.

Statistical analysis

Statistical analysis was performed using STATA (release 11.0; StataCorp, College Station, TX, USA) statistical software. Categorical variables will be presented as numbers and percentages with 95% confidence interval (CI), and continuous variables, as means ± standard deviation (SD) or median and range, depending on the distribution of data. In this propensity score matched analysis, we compared the baseline covariates between the 2 intervention groups, TRI and TFI. Continuous variables were compared using the *t*-test, and categorical variables were compared using either the chi-square test or Fisher's exact test as appropriate. A two-sided *p*-value of less than 0.05 was considered statistically significant.

To investigate the treatment effect (i.e. radial approach vs femoral approach) on the different clinical outcomes, such as 30-day MACE, major bleeding, minor bleeding, and longer DTB time >90 min, univariate and multivariate stepwise logistic regression analyses were applied. In the multivariate stepwise logistic regression analysis procedure, variables with $p \leq 0.1$ in the bivariate analysis were further considered for inclusion in the multiple logistic regression model so as not to miss any potentially important predictors. To choose among competing models, the preferred logistic regression model was selected based on the log-likelihood ratio. The treatment effect on clinical end points was quantified using the odds ratio (OR) estimate and its associated 95% CI.

To estimate the treatment effect on the continuous outcome of DTB time, the generalized linear model (GLM) using Gaussian family, identity link function, and main effect model was exploited. Further adjustment for potential confounders was made in this analysis. In addition, pair-wise comparisons for the mean values of DTB times between 2 treatment groups and other significant factor variables were also estimated.

We also performed an additional analysis to confirm the above analysis based on adjusted treatment effects (i.e. adjusted for significant covariates) using the propensity score matched analysis approach to provide unbiased estimation of treatment effect, which usually occurred in the observational study because the effectiveness of a treatment may depend on some characteristics that are associated with non-random assignment of treatment. In this propensity score matched analysis, we compared the baseline covariates between the 2 intervention groups. Continuous variables were compared using the *t*-test, and categorical variables were compared using either the chi-square test or Fisher's exact test as appropriate. A two-sided *p*-value of less than 0.05 was considered statistically significant.

Then, we estimated the propensity scores based on the logistic regression model, using all clinically important variables to estimate the probability of receiving 2 different treatment groups. Then, we performed propensity score matching. The propensity score matching technique [11] used in this study was the nearest-neighbor matching within specified calipers [12] using the logic of the propensity score without replacement with 1-to-1 matching (1 TRI:1 TFI) using random ordering observation. The value of the caliper was calculated by multiplying the SD of the mean estimated propensity score by 0.25 [12].

After matching, we further tested the balancing of propensity scores for each covariate between the 2 treatment groups. The estimated mean bias in propensity score was 5.8% and 14.6% in the propensity score matched sample and in the raw sample (before matching), respectively. The propensity score matched sample contained 283 subjects each in both treatment groups (TRI vs TFI) with 1:1 allocation. We finally estimated the treatment effects [11,13] on the primary and secondary outcomes of interest using average treatment effect on the treated (ATT) (TFI effect) and average treatment effect (ATE) (TFI–TRI).

The National University Hospital Institutional Review Board approved the study and global consent for the collection of personal health care information for non-commercial research purposes was obtained from all subjects upon admission.

Results

From January 2008 to April 2010, 1052 patients underwent primary PCI within 12 h of STEMI at the National University Heart Centre. Penetration rate of TRI in our center and distributions of each operator are shown in Table 1. During this period, the proportion of TRI was getting higher year by year from 27% in 2008 to 51% in 2010. Of these patients, 359 were selected for TRI and the remaining 693 patients underwent TFI. Baseline characteristics of both the TRI and TFI groups are presented in Table 2. Our Asian patients' body mass index (BMI) were $24.6 \pm 3.4\ kg/m^2$ in the TRI group, and $24.5 \pm 2.5\ kg/m^2$ in the TFI group ($p = 0.55$). The mean systolic blood pressure (BP) was significantly higher in patients with TFI when compared with the TRI group (reference group)

Table 1
Distribution of elective percutaneous coronary intervention in our center.

	Years		
	2008	2009	2010
A.			
Access site			
TRI	27%	32%	51%
TFI	73%	68%	49%
B.			
Operators			
#1	3%	5%	16%
#2	28%	35%	56%
#3	67%	74%	80%
#4	29%	32%	42%
#5	2%	4%	8%
#6	N/A	70%	62%

(A) Distribution of TRI and TFI by years in our center. (B) Percentage of TRI by each operator. Operator #6 joined our center from 2009.

Table 2
Baseline characteristics of the patients before propensity score matching.

Variables	Access site		*p*-Value
	TRI (*N* = 359)	TFI (*N* = 693)	
Age	55.8 ± 11.3	57.0 ± 12.1	0.11
Systolic BP	123.6 ± 25.4	135.7 ± 29.8	**<0.001**
Heart rate	80.5 ± 19.7	80.5 ± 20.0	0.98
Height	166.8 ± 5.8	166.6 ± 5.9	0.52
Weight	68.6 ± 11.2	68.0 ± 8.7	0.37
BMI	24.6 ± 3.4	24.5 ± 2.5	0.55
Gender			
Female	46 (12.8%)	107 (15.4%)	0.25
Male	313 (87.2%)	586 (84.6%)	
Race			
Chinese	201 (56.0%)	366 (52.8%)	0.62
Malays	74 (20.6%)	144 (20.8%)	
Indians	57 (15.9%)	116 (16.7%)	
Others	27 (7.5%)	67 (9.7%)	
Hypertension			
No	188 (52.4%)	345 (49.8%)	0.43
Yes	171 (47.6%)	348 (50.2%)	
Diabetes			
No	254 (70.8%)	475 (68.5%)	0.46
Yes	105 (29.2%)	218 (31.5%)	
Previous stroke			
No	352 (98.1%)	670 (96.7%)	0.2
Yes	7 (1.9%)	23 (3.3%)	
Previous MI			
No	332 (92.7%)	632 (91.2%)	0.391
Yes	26 (7.3%)	61 (8.8%)	
Previous PCI			
No	344 (95.8%)	635 (91.6%)	**0.01**
Yes	15 (4.2%)	58 (8.4%)	
Previous CABG			
No	357 (99.4%)	681 (98.3%)	0.16
Yes	2 (0.6%)	12 (1.7%)	
CKD			
No	357 (99.4%)	669 (96.5%)	**0.004**
Yes	2 (0.6%)	24 (3.5%)	
PAD			
No	356 (99.2%)	685 (98.8%)	0.76
Yes	3 (0.8%)	8 (1.2%)	
CK-MB			
Normal	319 (88.9%)	679 (98.0%)	**<0.001**
Abnormal	40 (11.1%)	14 (2.0%)	
AMI site			
Anterior	181(50.4%)	374 (54.0%)	0.27
Non-anterior	178 (49.6%)	319 (46.0%)	
Stent type			
BMS	258 (71.9%)	471 (68.0%)	0.19
DES	101 (28.1%)	222 (32.0%)	
Cardiogenic shock			
No	349 (97.2%)	671 (96.8%)	0.73
Yes	10 (2.8%)	22 (3.2%)	
GP IIb/IIIa inhibitor			
No	113 (31.5%)	441 (63.6%)	**<0.001**
Yes	246 (68.5%)	252 (36.4%)	

Table 3
Comparisons of clinical outcomes between TRI and TFI.

Outcomes	TRI (*N* = 359)	TFI (*N* = 693)	*p*-Value
30-Day MACE			
(+)	4 (1.1%)	22 (3.2%)	
(−)	355 (98.9%)	671 (96.8%)	0.057
Major bleeding			
(+)	20 (5.6%)	23 (3.3%)	
(−)	339 (94.4%)	670 (96.7%)	0.08
Minor bleeding			
(+)	6 (1.7%)	12 (1.7%)	
(−)	353 (98.3%)	681 (98.3%)	0.094
Door-to-balloon time > 90 min			
(+)	36 (12.4%)	128 (21.4%)	
(−)	255 (87.6%)	470 (78.5%)	**0.001**

(135.7 ± 29.8 mmHg vs 123.6 ± 25.4 mmHg; $p < 0.001$). The proportion of patients with a previous history of PCI and presence of chronic kidney disease (CKD) before the procedure was significantly higher in the TFI group when compared with the TRI group. However, creatine kinase-MB value at admission and the proportion of use of GP IIb/IIIa inhibitor was significantly higher in the TRI group compared with the TFI group. The distribution of age, gender, race, heart rate, height, weight, BMI, histories of hypertension, diabetes, stroke, myocardial infarction, coronary artery bypass graft (CABG), peripheral artery disease, acute myocardial infarction site, stent type and presence of cardiogenic shock were similar between the 2 treatment groups (Table 2).

The unadjusted mean DTB time in the TFI group (72.9 ± 40.2 min) was significantly longer compared with the TRI group (63.6 ± 25.0 min) ($p = 0.0003$). Unadjusted MACE (1.1% vs 3.2%, $p = 0.057$) was not significantly different in both TRI and TFI group (Table 3). There were 15 deaths, 4 myocardial infarctions, and 3 revascularizations in the TFI group, and 2 deaths, 2 myocardial infarctions, and 0 revascularizations in the TRI group. Unadjusted major bleeding (5.6% vs 3.3%, $p = 0.08$) and minor bleeding (1.7% vs 1.7%, $p = 0.094$) were not significantly different (Table 3). There was a twofold greater use of GP IIb/IIIa inhibitor in the TRI group (68.5%) compared with the TFI group (36.4%) ($p < 0.001$) (Table 2).

In the multivariate stepwise logistic regression analysis, heart rate was a predictor for 30-day MACE with adjusted OR of 1.03 (95% CI: 1.01–1.04, $p = 0.003$) (Table 4). However, no significant difference in 30-day MACE was seen in the two groups.

The major bleeding and minor bleeding rates were similar between the TFI and TRI groups, and being a member of the Malay population was a major predictor for major bleeding. Adjusted OR of the Malay population for development of major bleeding was 3.10 (95% CI: 1.03–9.34, $p = 0.044$) (Table 4).

Table 4
Adjusted treatment effect of TFI on outcomes: 30-day MACE, major and minor bleeding.

Outcomes	Variables	Adjusted odds ratio	95% CI	*p*-Value
30-Day MACE	Heart rate (bpm)	1.03	1.01–1.04	**0.003**
	TFI	2.91	0.99–8.53	0.052
Major bleeding	Race (Malay)	3.10	1.03–9.34	**0.044**
	Race (Indian)	1.09	0.22–5.49	0.914
	Race (others)	3.08	0.75–12.61	0.117
	TFI	1.01	0.37–2.72	0.99
Minor bleeding	Race (Malay)	0.35	0.12–1.00	0.051
	Race (Indian)	0.68	0.28–1.66	0.392
	Race (others)	0.86	0.29–2.51	0.777
	TFI	0.59	0.32–1.09	0.09

A multivariate stepwise logistic regression approach was used that included all baseline characteristics in Table 2.

Table 5
Adjusted treatment effect estimates for door to balloon time using generalized linear model (GLM).

Variables	Adjusted regression coefficient (β)	95% CI	p-Value
A.			
Age (years)	0.39	0.19–0.58	**<0.001**
Heart rate (bpm)	0.15	0.03–0.27	**0.015**
Previous CABG	28.05	4.61–51.49	**0.019**
TFI	8.58	4.30–12.86	**<0.001**
Variables	Mean door-to-balloon time (min)	95% CI	p-Value*
B. Pair-wise comparisons of door to balloon time between significant factor variables			
Previous CABG (−)	69.5 ± 1.2	66.45–72.61	**<0.001**
Previous CABG (+)	97.6 ± 11.7	67.01–128.16	**<0.001**
TRI	64.1 ± 1.5	60.21–67.88	**<0.001**
TFI	72.6 ± 1.6	68.49–76.76	**<0.001**

* Bonferroni adjusted p-values for multiple comparisons.

The GLM using Gaussian family, identity link function and main effect model showed that the DTB of TFI group was 8.6 min longer than that of TRI group after adjusting for significant variables such as age, heart rate, and previous history of CABG in the model [adjusted regression coefficient (β) for TFI: 8.58, 95% CI: 4.30–12.86, Bonferroni adjusted $p < 0.001$] (Table 5A). The adjusted mean DTB for the TRI and TFI groups were 64.1 ± 1.5 min and 72.6 ± 1.6 min, respectively (Table 5B). The mean DTB time for the group without a previous history of CABG and the group with a previous history of CABG were 69.5 ± 1.2 min and 97.6 ± 11.7 min, respectively (Table 5B).

Propensity score matching identified 283 matched pairs for DTB time, 30-day MACE, and bleeding analysis (Table 6). All the above findings were confirmed again by propensity score matched analyses (Table 7). The propensity score matched analyses showed that the estimated ATT of TFI had a significantly longer DTB time when compared with their propensity score matched control group (TRI) (69.4 min in TFI vs 63.6 min in TRI, $p = 0.027$) (Table 6). We did not see any significant differences in 30-day MACE, major and minor bleeding between the TRI and TFI groups (Table 6).

Discussion

In this single-center observational study investigating differences in primary outcomes of TRI and TFI for patients with STEMI, we observed that the TRI group had a shorter DTB time compared with the TFI group.

TFI has been considered the gold-standard access site worldwide because of its long history of use, the wide availability of several dedicated catheters that performed well, and the possibility to exploit relatively large-diameter catheters and sheaths, should these be necessary for complex PCI. The femoral artery has been the preferred access site especially for primary PCI. The age of the operator and long-time expertise with TFI are often cited as reasons why traditionally trained operators are not keen to choose TRI [14]. Many interventional cardiologists are reluctant to use radial artery access for primary PCI because of its anatomical character of small lumen, and therefore a higher risk of spasm, as well as challenging subclavian and aortic anatomy pathways. It is frequently felt that the use of the transradial route to restore coronary flow is excessively time consuming in STEMI cases. These had been perceived as the reasons for the considerable delay in DTB time.

However, our study has shown that DTB time was not prolonged in the TRI group, which supports the findings of 3 other studies [7,15,16]. In our study, multivariate analysis showed that a previous history of CABG was a major predictor for prolonged DTB time. It is well known that TRI has a steep learning curve compared with TFI, and cases of prior CABG should not be selected for TRI unless the procedure is performed by the most experienced operators [17]. We have not compared DTB time between groups with and without a previous history of CABG, but after propensity score matching, our results showed significantly shorter DTB time in the TRI group. There may be other factors that affect DTB, which would include operator's experience and judgment. Those factors are difficult to be statistically analyzed.

Because radial artery diameter correlates well with anthropometric measurements, concerns remain over whether radial access failure and spasm may occur more frequently in Asians than in Caucasians. The mean height and weight of our patients were 166.6 ± 5.8 cm and 68.3 ± 9.6 kg. Maddury et al. reported

Table 6
Propensity score matched analysis to detect average treatment effect (TRI vs TFI) on outcomes.

Variables	TFI	TRI	Difference	S.E.	T-Stat	p-Value
Door-to-balloon time						
Unmatched	72.9 (min)	63.6 (min)	9.28	2.57	3.61	**0.0003**
ATT	69.4 (min)	63.6 (min)	5.77	2.61	2.21	**0.027**
30-Day MACE						
Unmatched	3.0 (%)	1.0 (%)	2.0	1.0	1.70	0.894
ATT	3.0 (%)	1.0 (%)	2.0	1.0	1.52	0.129
Major bleeding						
Unmatched	1.5 (%)	1.0 (%)	0.47	0.83	0.57	0.571
ATT	2.1 (%)	1.1 (%)	1.06	1.05	1.01	0.313
Minor bleeding						
Unmatched	3.7 (%)	5.5 (%)	−1.82	1.45	−1.26	0.209
ATT	6.0 (%)	5.3 (%)	0.7	1.94	0.36	0.714
Door-to-balloon time > 90 min						
Unmatched	21.4 (%)	12.4 (%)	9.03	2.76	3.27	**0.0011**
ATT	17.7 (%)	11.7 (%)	6.01	2.97	2.02	**0.043**

Clinical outcomes before and after propensity score matched analysis using 1:1 matching without replacement.

Table 7
Bias reduction diagnostics for comparing the distribution of baseline covariates between treatment groups in propensity-score matched sample before and after matching.

Variables	TFI	TRI	% bias	% reduction bias	*p*-Value
Age					
Unmatched	56.9	55.7	9.9		0.173
Matched	56.9	55.6	10.5	−5.9	0.212
Gender (male)					
Unmatched	0.86	0.89	−8.1		0.263
Matched	0.88	0.88	−2.1	73.9	0.796
Race[a] (Malays)					
Unmatched	0.21	0.2	0.7		0.919
Matched	0.24	0.2	7.9	−983	0.363
Race[a] (Indians)					
Unmatched	0.16	0.16	−1.2		0.867
Matched	0.14	0.17	−8.6	−620.6	0.295
Race[a] (others)					
Unmatched	0.1	0.07	9.5		0.196
Matched	0.1	0.07	7.6	20	0.366
Systolic BP					
Unmatched	136.1	125.2	39.3		**<0.001**
Matched	127.9	125.9	7.2	81.5	0.363
Heart rate					
Unmatched	80.4	80.5	−0.6		0.934
Matched	80.4	80.4	−0.1	87.8	0.993
BMI					
Unmatched	24.5	24.5	−0.4		0.95
Matched	24.4	24.4	−0.4	18.4	0.965
Previous PCI					
Unmatched	0.08	0.03	20.4		**0.007**
Matched	0.05	0.04	4.5	77.7	0.524
CKD					
Unmatched	0.03	0.01	16.4		**0.037**
Matched	0.01	0.01	5.4	67.2	0.413
Diabetes					
Unmatched	0.31	0.29	4.6		0.526
Matched	0.29	0.29	0.8	83	0.926
GP IIb/IIIa inhibitor use					
Unmatched	0.37	0.74	−79.1		**<0.001**
Matched	0.66	0.73	−16	79.7	0.056
DES					
Unmatched	0.32	0.28	7.5		0.298
Matched	0.27	0.29	−3.1	58.8	0.708
Cardiogenic shock					
Unmatched	0.03	0.02	7		0.346
Matched	0.03	0.02	6.6	5	0.433

[a] Race (Chinese) served as a reference group.

that elective TRI was feasible and safe in Asian females (average height, 151.7 ± 8.4 cm; average weight, 58.1 ± 12.5 kg; average BMI, 25.2 ± 4.6 kg/m^2) [18]. However, only 90 patients were included in this study. In the RIVAL study [19], patients with BMI > 25 kg/m^2 comprised 69.2% of all patients, and in the REAL multicenter registry [5], the mean BMI was 27.3 ± 4.3 kg/m^2 in the TRI group and 26.8 ± 4.1 kg/m^2 in the TFI group. In the HORIZONS-AMI trial [6], the mean BMI was 27.3 kg/m^2 in the TRI group and 27.1 kg/m^2 in the TFI group. In contrast, our study comprises samples whose mean BMI was 24.5 ± 2.8 kg/m^2. Our Asian patient population had obviously smaller body size than previous studies as expected. Through this study, we found that primary PCI with radial access is as successful as with femoral access despite the smaller radial artery size in Asians. This is consistent with the findings in other studies based on Caucasian and non-Asian populations [1–7]. BMI itself may not always represent body size, however a previous study showed that femoral artery diameter size was correlated with BMI [20].

Approximately 50% of interventional cardiologists think that TRI practice will increase in the future especially in the USA, India, and China [14]. Meta-analyses have revealed significant reductions in mortality, MACE, major bleeding events, and access site complications of radial vs femoral PCI [1,2,7]. Arzamendi et al. showed a fourfold reduction in bleeding and significant MACE reduction with the radial approach in primary PCI [21]. In our study, there was a trend that 30-day MACE was lower in the TRI group, but not significantly ($p = 0.129$). In the recently reported randomized RIFLE-STEACS study, TRI was associated with significantly lower rates of cardiac mortality and bleeding [22], which reflects the same trend as our study.

A perceived benefit of TRI in STEMI is that operators are no longer constrained in their choice of anti-thrombotic treatment because of the reduction in access site bleeding with TRI. Nowadays we have a variety of choices of antiplatelet agent [23], to select better agents bleeding complications should be minimized. In our study, operators used GP IIb/IIIa inhibitors more liberally in TRI patients compared with TFI patients, likely accounting for the lack of bleeding reduction that is frequently observed with TRI. This is in contrast to the results of Arzamendi et al.'s study, in which TRI was associated with less bleeding despite more frequent GP IIb/IIIa inhibitor use [21]. We therefore suggest that the use of GP IIb/IIIa inhibitors be guided by clinical need rather than access site, as major bleeding frequently occurs in anatomical locations distant from the access site.

Although we used propensity score matched analysis, selection bias for the TRI and TFI groups cannot be completely excluded. Before matching, there were 15 deaths, 4 myocardial infarctions, and 3 revascularizations in the TFI group, and 2 deaths, 2 myocardial infarctions, and 0 revascularizations in the TRI group. Despite a carefully performed propensity-matched analysis, the TFI group

has residual unmeasured bias that cannot be corrected by propensity score matched analysis.

This study has limitations related to study design and methods of data collections. First, it is a retrospective non-randomized study where all confounding factors and biases could not be eliminated from the picture. There is a possibility of substantial selection bias with regard to patient selection, as well as the experience and dedication of the operators. However, by performing propensity-matched analysis, we did minimize the bias considerably (Table 7). Second, conversion from radial access to femoral access, and vice versa, was not systematically captured in this study. Radial access failure is higher than femoral access failure in most studies and this may account for the longer DTB with radial access in other studies. Third, sheath size was not systematically captured in this study. Greater sheath size is associated with increased access site bleeding. The default sheath size for both TRI and TFI in our center is 6F. An inventory review during the study period showed that 88% of sheaths used were 6F.

In conclusion, TRI was not associated with longer DTB times than TFI in this single-center propensity-matched analysis of patients undergoing primary PCI for STEMI. Our data show that the transition to TRI in STEMI can be safely achieved with DTB times that are comparable and possibly better than TFI.

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